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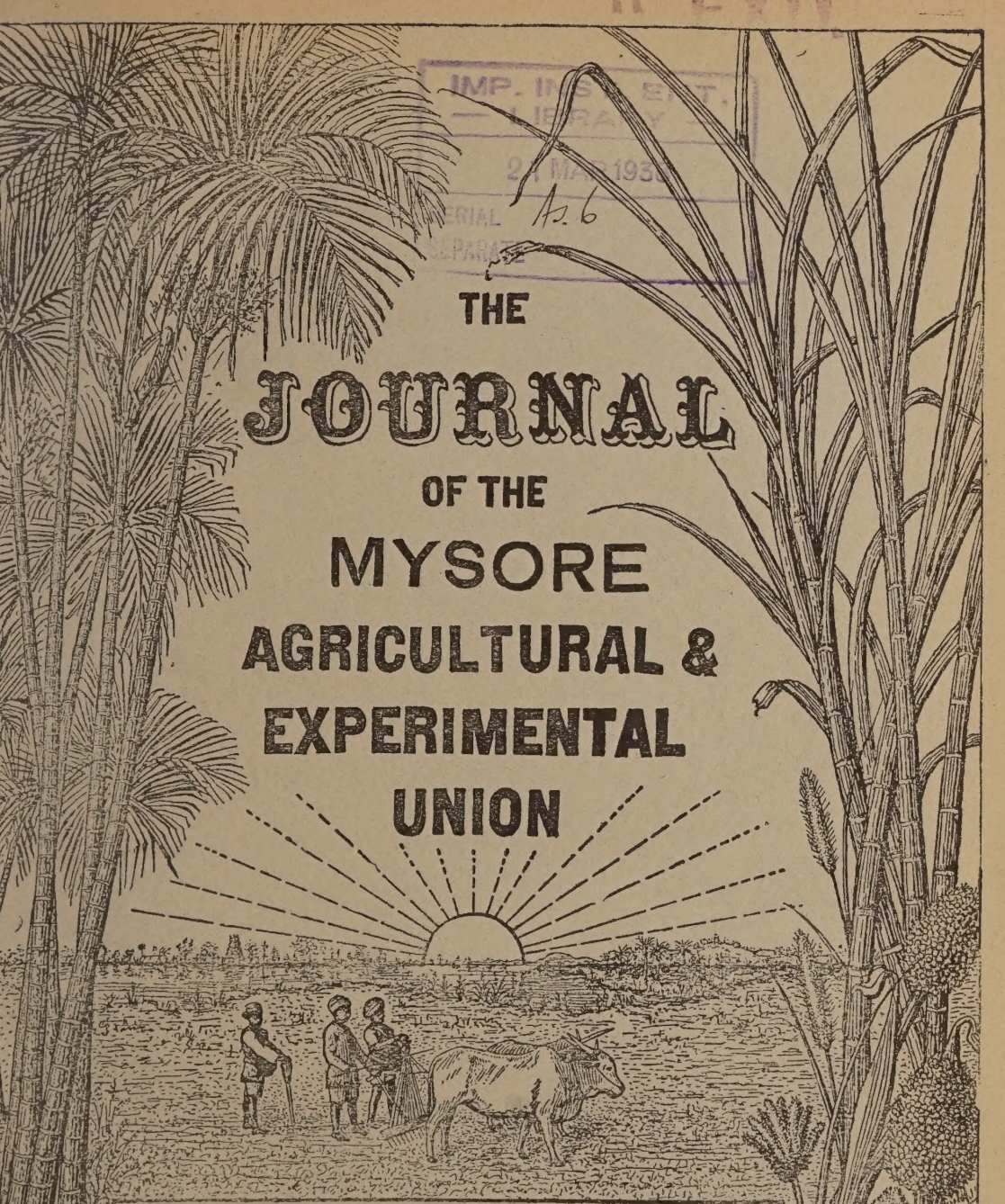

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Vol. XVII] [No. 2

Some Common Diseases of Poultry in Mysore and How to Deal with Them

By

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Poultry in Mysore are victims to a great variety of diseases most of which are fatal to them. For this reason poultry farming is not being taken up extensively by the rural population in the State although it could be a very valuable cottage industry.

Ill-health in poultry may arise from heriditary factors, from defects of management, from attacks of disease-producing agents or from a combination of any or all of these, as is usually the case under rural conditions of poultry-rearing in the State. Whatever the precise cause of trouble, there can be nothing more sure than that the goal to aim at is its prevention.

It is essential that a knowledge of the nature and symptoms of the various troubles to which the Fowl is prone, should be possessed by every keeper of birds in order that poultry farming may be a remunerative occupation. The

object of this paper is to bring home to the layman the most important diseases to which his poultry usually succumb, the characteristic symptom or symptoms which would enable him to diagnose them more accurately and the practical hygienic or prophylactic measures he could adopt to decrease the incidence and prevent the spread of such diseases in them.

In describing the most common diseases of the domestic fowl, only those that have a tendency to spread rapidly among poultry and cause the greatest damage to them are taken into account. They may be considered under the following four headings:—

1. Diseases caused by Parasites.
2. Diseases caused by Protozoa.
3. Diseases caused by Bacteria.
4. Diseases caused by Filterable Viruses.

1. Diseases caused by Parasites

Parasites that occasion heavy damage to poultry are those that are harboured in the intestinal canal and usually termed worms. If one happens to conduct *post-mortem* on a dead bird, takes out the intestines and cuts through them, it is not seldom that he encounters two types of worms: the round worms and the tape worms. The death of any bird from effects of internal parasites should be looked upon with apprehension, as serious results are often met with where massive infestation occurs.

Round Worms.—Round worms are the most common of the internal parasites and flocks infested with large numbers of these are unprofitable in the extreme. The birds are unthrifty, appear unkempt and suffer from diarrhœa and constipation. Young stock are most severely affected; they lose their weight; are stunted in growth and become very poor layers.

Tape Worms.—More than thirty different kinds of tape worms are found to inhabit the alimentary tract of the fowl.

Symptoms.—If a bird is infested by large numbers of tape worms, it is robbed of much food and the bird becomes unthrifty, shows a ruffled appearance of feathers and loss of

flesh. As a result of the irritation produced by these worms, derangement of digestion, catarrhal conditions of the bowels and in laying hens, a loss of egg production and in growing birds a stunted growth are usually observed. Many tape worms often cause death of the infested bird both directly and indirectly by rendering them highly susceptible to other infections.

Treatment.—To keep the birds permanently healthy and free from worms, it is always judicious to dose them periodically for worms—say at least every three months. Most of the fowls are found harbouring both round and tape worms simultaneously and as such, it is necessary that the treatment adopted is such as would expel both these varieties of worms. There is a large number of prescriptions in vogue intended for dosing poultry for worms, but by far the simplest and cheapest appears to be a mixture of finely powdered *Butea frondosa* and *Areca semina* (powdered areca nut) in suitable doses. These drugs are indigenous and could be obtained in all places. They are best given in doses of five grains each per bird mixed up in wet mash and fed to poultry for three consecutive days, to be followed on the third day with suitable doses of Mag. Sulphas in drinking water. In the absence of *Butea frondosa* 10 to 20 grains of powdered betel nut may be given to each of the birds kept starving for at least 18 hours.

Prevention.—One of the most important measures against all parasitic infestations of the digestive canal is to move the fowls upon fresh ground every two or three years. Another practical measure which may be adopted at the same time, is to remove the excrement daily from the houses and destroy any parasites or their eggs which may be in it, by mixing it with quicklime or by burning it. Frequent inclusion of garlic in the food and sprinkling tobacco dust into the mash have a deleterious effect on the worms.

Sick birds should always be isolated and confined and their droppings should either be burnt or treated with lime.

Without these hygienic measures, medical treatment can only be partially successful.

2. Diseases caused by Protozoa

The most common disease of the fowl under this head is the Coccidiosis, caused by a very minute, unicellular animal organism, *coceidium.*

Symptoms.—In young chicks, the disease develops rapidly and the death-rate is usually high. The chick is weak, wings droopy due to muscular weakness, loss of appetite, or in some cases, birds may even continue to eat. The chicks stand in bunches and peep much of the time. The droppings are fluidy, whitish or whitish-brown coloured and paste up the vent region and may prevent bowel movement. The discharges may be streaked with blood.

Post-mortem Findings.—On opening the body cavity, the intestines appear congested and present ulcers throughout the tract, especially the cæca, which may be filled with a bloody semi-solid mass distending the organ considerably.

Treatment.—Give one-third teaspoonful of *Tr. Catechew* to each gallon of drinking water. Give the birds all the butter-milk or sour skimmed milk which they will drink. Immediately remove all the sick birds and clean up and scrub the floor with a powerful disinfectant, such as a 1 : 1000 solution of Bichloride of mercury or a strong solution of copper sulphate.

3. Diseases caused by Bacteria

Under this, three important diseases need be described,

(*a*) Fowl cholera,
(*b*) Bacillary white diarrhœa,
(*c*) Fowl typhoid.

(*a*) *Fowl Cholera.*—This is one of the most common and a highly fatal disease of poultry caused by a very minute organism, *pasteurella avicida.*

Mode of spread.—The germs are eliminated from the body of the sick fowl through the bowel discharges, thus infecting the soil and polluting drinking water and feed.

Symptoms.—Depression is usually the first symptom; the face, comb and wattles usually get darkened and discoloured. An exceptional thirst is characteristic of the disease. The droppings are greenish-red and watery. Respiration is increased and later becomes laboured. Complete prostration sets in, preceding death.

Post-mortem Appearances.—Body emaciation is not apparent. In some instances there is a darkening of the breast muscles. The layer of fat on the heart is studded with pin-point hæmorrhages. The intestines show an acute hæmorrhagic inflammation and the contents are mixed with a bloody mucus material.

Diagnosis.—Accurate diagnosis is based on the microscopical finding of the casual organism in a stained smear of the blood taken from a sick or dead bird and could be undertaken only in a laboratory. It is therefore wise, in such cases, to get the diagnosis confirmed in a bacteriological laboratory by sending an ailing or dead bird.

Treatment and Prevention.—The treatment of sick birds with specific immune serum in the initial stages of the disease has been successfully reported in some instances. But a more effective method of controlling the trouble is through the use of a vaccine. Strict isolation of the sick birds, cleaning and disinfecting the houses and premises and the disinfection of drinking water through an effective germicide like Chinosol are to be advocated.

(*b*) *Bacillary White Diarrhœa.*—Commonly known as pullorum disease of chicks is a devastating ailment of very young chicks caused by a minute germ, *salmonella pullorum.* The heaviest loss in chicks is from the first to the fourteenth day after hatching.

Symptoms.—In infected chicks, the wings are droopy and the feathers ruffled. The birds appear drowsy and eject

out a frothy brownish-white diarrhœa very frequently. There is a tendency for the abdomen to bulge. The chicks usually die in large numbers. Chicks having the infection when young and recovering from it subsequently, retain the germs in the ovaries as adults and transmit the disease to the progeny, a consideration which is not to be overlooked in undertaking preventive measures.

Post-mortem Findings.—Yellowish-brown colouration of the liver, congested kidneys, unabsorbed yolk sac are some of the usual pathological lesions observed.

Control.—Experiments indicate that feeding with sour milk (butter-milk) has a tendency to reduce mortality.

The elimination of the disease lies in the elimination of reacting adults from the flocks. The reactors are easily recognised by means of a reliable serological test—Agglutination test—which could be undertaken only by an experienced bacteriologist.

(*c*) *Fowl Typhoid.*—Also known as Klein's disease of the fowl is a septicæmic infection of poultry caused by another minute organism, *salmonella gallinarum.*

Occurrence.—Fowl typhoid is usually a disease of the adult bird and range birds, occurring in late Autumn and early Spring. The germ is voided in large numbers by birds suffering from the disease and is transmitted from place to place by surface washings, mechanical conveyers such as animals and man, streams and brooks, etc.

Symptoms.—The disease is of such a character that it may well establish itself before any symptoms are observed. The bird shows signs of dosing and on being disturbed exhibits a weakness of gait. The droppings are watery and sulphur coloured. The loss of flesh may be rapid according to the severity of the disease. The face and comb are usually highly anæmic.

Post-mortem Findings.—The carcass is usually emaciated, the liver greatly enlarged, streaked and friable and the spleen enlarged.

Control Measures.—Strict sanitary precautions are to be observed; all sick birds should be isolated and destroyed. Some potent disinfectant to be added to the drinking water and if possible, the birds should be removed to new grounds. But by far the most effective method of controlling the disease is to vaccinate all the birds, if possible, with an autogenous vaccine. This could be done through timely intimation to the Veterinary Department.

4. Diseases caused by Filterable Viruses

By far the most infectious diseases of poultry are those caused by a host of ultra-microscopic organisms, known as filterable viruses and which are so small that they cannot be seen under the microscope. These ailments are characterised by rapid spread when once they appear in the flock and in most cases by a sad lack of methods of controlling them. The most common diseases under this head encountered among the poultry in Mysore are:

(*a*) Chicken Pox and Roup,
(*b*) Fowl Pest,
(*c*) Ranikhet Disease.

(*a*) *Chicken Pox and Roup.*—These two diseases cause serious loss to poultry farmers by decreasing the egg production. They are dealt together, as they have a common etiological entity—the chicken pox virus.

Symptoms.—The first sign of the disease is a small red pimple on the comb, face and wattles, the nodules varying in size from a pin-head to that of a pea or even larger. Later these nodules ulcerate on the surface and it is in this condition some secondary organisms find an easy entry into the lesions and set up complications usually termed Roup or canker of the mouth. It is at this point one finds the disease-control hard.

Treatment.—Treatment for chicken pox consists in painting the affected part with Tincture of iodine or still better with a dilute picric acid solution.

Prevention.—All dead fowls should be burnt and sick ones removed immediately from the flock for treatment or for effective disposal. Vaccination of all the other birds must be undertaken with the help of an efficient vaccine, which could be done on application to the Veterinary Department.

(*b*) and (*c*) *Fowl Pest and Ranikhet Disease.*—These are the two very acute, highly infectious diseases of poultry encountered in the State, causing unaccountable damage to the industry.

The period of incubation is from 2 to 4 days in fowl pest and somewhat longer in the other—5 to 10 days. But it is not uncommon that chronic cases of fowl pest lingering on for one to two weeks and more acute cases of Ranikhet disease of a fulminating type are encountered, misleading one as to its identity.

Mode of Spread.—Fowls become infested through contaminated feed and water. They may be spread through droppings used as fertilizer, litter, feeding and drinking utensils, by wild birds such as sparrows and crows.

Symptoms.—The diseases are characterised by their extremely infectious nature, rapidly progressing course and high mortality in the affected flock. The birds drink considerable water, soon lose the use of their wing muscles resulting in their dropping. As disease progresses the comb and wattle become dark, symptoms of paralysis appear, beginning at the legs and in the last stages the birds lie down comatosed and die.

Post-mortem Lesions.—In both these diseases all lesions may be absent or found only in part. The diagnosis of these two ailments of poultry is by no means easy, especially by a layman and involves careful examination of very minute lesions in several organs and resorting to some specific bacteriological and serological tests which could be carried out only in a well-equipped laboratory. For these reasons, it is advisible to get the advice from the Department when the disease appears in a flock.

Control Measures.—There is no remedy from a medical standpoint. Attempts to prepare immune sera and specific vaccines against the disease by a host of workers in the line have been futile so far. These problems are also being tackled by the Veterinary Department in the State and one may expect to find some hopeful solution in course of time. Till then all efforts should be directed towards prevention of the spread of the disease by taking recourse to the following:

Sick fowls should be disposed off promptly without contaminating the premises and the carcases burnt. The healthy fowls should be removed to new quarters and carefully watched for signs of disease. Houses and rooms should be thoroughly disinfected with an efficient disinfectant like Cresol (3%). The drinking water may be rendered safe by adding Chinosol in dilutions of 1 in 10,000.

Some Flowers Visited by the Indian Honey Bee (*Apis indica*, Fabr.)—I

By

N. Venkatsubbaya, F.R.H.S.

The study of bee flora has received hardly any attention in India. This is not strange, for the scientific study of the industry itself is of recent date. Until recently Indian publications on bee-keeping were admittedly compilations from foreign literature on the subject. The honey bee referred to in European or American literature on bee-keeping is different from the Indian honey bee.

That Mysore has its own honey flora is beyond dispute. In the *malnads,* the collection and trade in honey is a well-known industry. Most of this honey, however, is the product of the wild bee, *Apis dorsata* (Rock bee—ಹೆಜ್ಜೇನು) which cannot be domesticated. In some parts of the *malnad* the keeping of a few pot-hives of *Apis indica* (honey bee—ತುಡುವೆ) in the backyards is a subsidiary industry of comparatively small dimensions. Even in the *maidan* parts of the State, honey is collected in the jungles from the

combs of the rock bee and honey bee. There is considerable amount of natural bee flora in the country but the supply of bee food is confined to the flowering season of these plants, a fact which accounts for the varying yield of honey from the hives.

The study of wild honey flora would furnish valuable information indicating localities in which apiculture might be profitably taken up. Extension of cultivation of agricultural or horticultural plants having the additional value as bee flora would provide another good source of food for the bee.

The garden city of Bangalore is an ideal place for the study of bee flora. There are many fruit gardens both within it and outside it in fairly close proximity. The city abounds in flower gardens, both public and private. With a climate comparatively free from extremes and two fairly prolonged flowering seasons, Bangalore is difficult to excel as a suitable place for bee-keeping.

Quite a large number of exotic fruit and flower plants grow well here, and many of them are visited by the honey bee when they are in blossom and furnish it plenty of pollen and nectar. Local fruit gardeners do not seem to realise the importance of the bee as a cross-pollinating agent. One reason why a large number of flowers drop without setting fruit is want of pollination. Bees are excellent pollinating agents and this fact is well known in other fruit-growing countries of the world. A few hives of bees are generally kept in fruit gardens for enabling cross-pollination. Sometimes gardeners hire out hives of bees during the blooming season for this purpose.

Many insects visit flowers and, among bees themselves there are at least four well-known species here competing for food. These are (*a*) the rock bee, *Apis dorsata,* (*b*) the honey bee or *Apis indica* which is smaller than the wild bee and can be domesticated, (*c*) *Apis florea,* a bee smaller than *Apis indica* and (*d*) the very small dammar

bee (*Melipona vidua*, Lep.). A bee-keeper can easily recognize the honey bee.

A large number of exotic flower plants grown in Bangalore are known to have importance as bee flora in foreign countries. But as to whether they are visited by the Indian honey bee is a matter which can be determined only by careful observation. Every species of bee seems to have a flora of its own. The flowers visited by the rock bee are not always visited by the honey bee. The rock bee is a much larger and stronger insect and has a longer proboscis than that of the honey bee. The length of the proboscis of the European or American honey bees is stated to be about 6 mm., that of the rock bee and Indian honey bee are 6 mm. and 4.75 mm. respectively.* It is well known that tubular flowers almost always, if not always, contain honey. The proboscis of the bee should be long enough to reach the nectar at the base of the corolla tube. The nectar present in many of the tubular flowers is not accessible to the Indian honey bee.

The bee visits flowers either for pollen or nectar or both. It may be that among the flowers visited some furnish more nectar and less pollen, others more pollen and less nectar. The writer has observed the Indian honey bee visiting, in Bangalore, the following cultivated flower plants.

1. *Ageratum.*—Sometimes much visited by the bee both in the mornings and afternoons.
2. *Antigonon leptopus.*—Both the pink and white flowering kinds are great favourites with the bees. They are found on the flowers almost all the time of day.

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* The lengths of the proboscis of *Apis dorsata* and *Apis indica* were kindly measured for the writer by Mr. M. Puttarudriah, B.Sc. (Hons.), of the Entomological Section. The lengths are averages of six measurements taken from the tip of submentum to the tip of labellum as in the case of Carniolan bees which have a proboscis length of 6 mm.

3. *Aster* (China Asters—*Callistephus chinensis*).—Sometimes much visited in the afternoons but it is interesting to note that the better class of Asters such as the Giant Comet type with centres more or less covered by the petals do not seem to be in favour.
4. *Balsams.*—The single kinds mostly, not the double flowering ones. Sometimes visited early in the mornings.
5. *Calendula.*—Is much visited generally before mid-day.
6. *Calliopsis.*—Is much visited in the mornings and afternoons.
7. *Celosia cristata.*—Much visited, mostly in the afternoon.
8. *Centaurea cyanus.*—The ordinary blue corn flower seems to be a favourite. Is visited in the mornings and evenings sometimes even up to dusk. These flowers are very largely visited by *Apis florea* and dammar bees also.
9. *Cosmos.*—Much visited in the mornings and afternoons.
10. *Eutoca viscida.*—Is visited, but more observations are necessary.
11. *Gaillardia.*—Is much visited, in the mornings and afternoons.
12. *Heliotrope.*—Is a great favourite. Visited in the mornings and afternoons.
13. *Limnanthes Douglassii.*—Is visited, but more observations are necessary.
14. *Linaria purpurea.*—A species of megachile and humble bees visit this flower usually. Honey bees also visit it in the mornings.
15. *Marigold* (French).—Is visited late in the evening.

16. *Mathiola bicornis* (night-scented stock).—Seems to be a great favourite. Is visited very early in the morning before sunrise. Being a night-flowering plant, the flowers close up during the day but are open for about an hour in the morning.
17. *Mignonette.*—Visited but observations should be made by growing this plant on a larger scale than it was possible for the writer to do.
18. *Malcomia maritima.*—Is much visited before midday.
19. *Nasturtium.*—Is sometimes much visited in the mornings. As nectar in this flower is present at the bottom of a long spur beyond the reach of the honey bee, probably the bees collect only pollen from this flower.
20. *Phacelia tanacetifolia.*—Is visited but more observations are necessary.
21. *Salvia.*—Many species are visited generally in the mornings. A large number of bees was once seen on *Salvia leucantha* about midday.
22. *Scabiosa atropurpurea.*—The honey bee was observed visiting but more observations are necessary.
23. *Solidago canadensis.*—Is visited but observations should be made by growing it in a large bed or border.
24. *Sunflower.*—All kinds seem to be great favourites with bees. Varieties with a longer flowering season than the field sunflower should be used. Miniature Sunflower has a long flowering season and is much visited.
25. *Wall-flower* (single).—These are much visited, mostly in the mornings, sometimes in the afternoons.
26. *Zinnia.*—Is much visited.

Among herbs, borage (*Borago officinalis*) is much visited. *Digitalis purpurea* is visited early in the morning. Blossoms of tomato, cucumber and okra were found to be visited.

Shrubs.—Only a few have been observed. The following are much visited.

1. *Vitex Negundo,* Linn.—Chaste tree. Is much visited sometimes in the mornings and evenings even up to dusk. Flowers are bluish lavender, and fragrant from about 7 p.m.
2. *Petrea volubilis,* Linn.—This plant with beautifull sprays of blue flowers is much visited in the mornings.
3. *Lafœnsia macrophyla.*—Visited in the mornings. Observations were made on a single plant in the Government Botanical Gardens, Bangalore.
4. *Guaiacum officinale,* Linn.—Zygophyllaceæ. This West Indian shrub or small tree bearing bluish, fragrant flowers seems to attract the honey bee by the thousands all the day round. *Apis florea,* the dammar bee and even some wasps were also seen in large numbers on the flowers. The tree flowers during September. When it is in bloom the three, aforementioned shrubs seem to be neglected by the bee.

The annual flowering plants mentioned in this note were raised by the writer from seeds obtained from well-known florists. The perennial shrubs can be seen in the Government Botanical Gardens, Bangalore. Honey bees were not found visiting the following flowering plants at any time.

Antirrhinum.

Canna—Is visited by the dammar bee.

Carnation— Do.

Guaiacum officinale, Linn.

Chrysanthemum maximum (Shasta Daisy).
Convolvulus.
Dahlia.
Datura.
Larkspur. Light and dark blue.—Usually visited by a humble bee. A solitary honey bee was once seen buzzing near the deep blue flowers for a while, but did not alight on it.
Dianthus (Single and double pinks).
Gerbera.
Gomphrena.
Honey-suckle. (?)—
Lobelia erinus.—Blue.
Lupines.—White, blue and rose. These are much visited by a humble bee.
Mirabilis.
Petunia.—Single and double. A solitary bee was once seen buzzing near the blue flowers.
Phlox.—A humble bee is often seen seeking.
Portulaca.—Seems to be a favourite of the dammar bee.
Sweet peas.
Tithonoa speciosa.

Bees visit different flowers at different times of the day, indicating that they adapt the hour of their visit to the habit of the plant. Thus, *Mathiola bicornis* is visited from dawn to a little after sunrise when the flowers close up. *Mimosa* is visited very early in the morning. Flowers of sunnhemp (*Crotolarea juncea*) open a little after 3 o'clock in the afternoon emitting a delicious fragrance. Almost simultaneously, a *megachile* (leaf cutting bee) is seen in large numbers alighting on the wing upon the flower, pressing down the keel and thrusting its proboscis in the opening effected thereby in an attempt to get at the nectar present at the base of the corolla. The honey bee has never been seen visiting this flower, the only other insect commonly visiting it being *Xylocopa* or the carpenter bee.

The subject of bee flora in India is yet unexplored. Careful observations will have to be made on agricultural and horticultural plants during the flowering season to determine which of them are sources of food for the honey bee. The source of bitter honey obtained during some months in Bangalore deserves to be determined. A reason for the comparatively small quantities of honey obtained from the hives of *Apis indica* seems to be the paucity of suitable honey flora.

The observations recorded here are intended to stimulate interest in the subject and if they serve the purpose, the writer is amply rewarded.

A Preliminary Study of Rainfall, Temperature and the Yield of Ragi in the Mysore State

By

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(*Department of Agriculture*)

Introduction.—Governments almost everywhere have been publishing forecasts of the principal crops of their countries by a method which depends mainly on personal inspection by crop reporters of the growing crops just before harvest. This method is purely subjective. On the other hand, forecasting crops with an objective basis, that is, from a scientific study of the influence of weather on crops, has been shown to be not only more accurate but in many cases available considerably earlier. The objective method is receiving greater attention in Western countries, particularly in the United States of America, where the science of Agricultural Meteorology has made great advances.

Historical Review.—The earliest researches in agricultural meteorology on the statistical side date back to 1874 and 1880. In 1874, Sir Rawson Rawson examined by non-mathematical methods, the relation between the sugar crop and rainfall in the Island of Barbados. In 1880, Lawes and

Gilbert studied the relation between the winter rainfall and wheat yield.

Work in England.—The publication of two papers by Sir Napier Shaw in 1905 on the relation between wheat yield and autumn rainfall, marks the renewal of interest after a lapse of nearly twenty-five years in research in agricultural meteorology. However, the credit of having applied statistical methods to such studies belongs to R. H. Hooker, who, in 1907 and 1921, surveyed the literature and studied by total and partial correlations, the influence of weather on each of the principal crops. In 1917 and 1918, Prof. Fisher did pioneer work by applying an ingenious method to overcome some of the difficulties in correlation work.

Work in Sweden and Mauritius.—In 1917 and 1918, Wallen made an exhaustive and intensive study of the correlation of weather and crops in Sweden. A. Walter, in 1910, studied the relation between the sugar crop and weather in Mauritius. He was the first worker who tried to work with effective rainfall and not the actual rainfall.

Work in the U.S.A.—In the United States of America much valuable work has been done. H. L. Moore, in 1917, worked on the cotton crop and weather, and his was the first scientific criticism of the official method of forecasting crops. Bradford Smith, in 1927, worked on the same subject and found "Methods for forecasting *inter alia* (1) the acreage of the cotton crop with surprising accuracy before the crop is planted and (2) the probable yield per acre of cotton, based on previous winter temperatures in the cotton belt, this also being calculated before the crop is even planted." Studies by Kincer in 1915, Kincer and Maltice in 1928, added much to the knowledge of agricultural meteorology.

On the experimental side of agricultural meteorology, much work has been done on the "Continent" by Dr. Geiger of Germany and Dr. Smidth of Vienna.

Work in India.—In India, on the other hand, no work of this kind seems to have been attempted until 1910. Jacob's work in 1910 and 1916 being the only work of this kind, the Royal Commission on Agriculture in India, remark that, "Very little attempt has been made to correlate the two sets of data; the two valuable studies published so far by Mr. S. M. Jacob, I.C.S. (Retd.), represent, so far as we are aware, the only instances of this kind." In 1929, Rao Sahib Mukund V. Unakar studied the relation between weather and crops with special reference to the Punjab wheat.

Only recently, the Imperial Council of Agricultural Research started work on agricultural meteorology at Poona. Intensive experimental and statistical work has been commenced by Dr. L. A. Ramdas, M.A., PH.D., etc., Agricultural Meteorologist, to investigate the exact relationship between plant growth, diseases and weather.

Objects of Present Study.—It is intended to study statistically the data available as regards rainfall, temperature, yield and acreage of some of the important crops in the Mysore State. This paper is an attempt at a preliminary statistical study of the relation between rainfall, temperature and ragi (*Eleusine coracana*) yield, ragi being the most important dry crop in the Mysore State. The investigation of the critical periods of rainfall and temperature controlling the crop would lead to the possibility of forecasting the yield of ragi per acre by the help of the weather data. In agricultural meteorology, the term "Critical Period" has a special significance. It is the period during which the plant reaches the maximum sensibility to a given weather factor, so that certain climatic conditions are necessary for the maximum growth-rate of the plants.

Annual precipitation with its seasonal and monthly distribution, has always been considered to be the most vital factor in controlling the growth and yield of crops, other important factors (probably less important) being temperature, intensity and duration of sunshine, temperature and

moisture content of the soil, evaporation, intensity of rainfall, etc. As a preliminary study, only two factors, rainfall and temperature, are considered.

It is recognised that this study suffers from severe limitations in that no attempt has been made to determine 'effective' rainfall by eliminating loss of moisture by evaporation, run-off and percolation, or to study secular trends in the data or to consider rainfall and temperature conditions over shorter periods than a month. Moreover, the yield data used in this study being based on ocular observations, cannot be expected to be so accurate as those of the experimental farms or data obtained by crop cutting experiments. In spite of all these limitations, this preliminary study indicates certain relationships between weather factors and ragi yield, from which an attempt is made to forecast the yield of ragi.

Before considering the data in detail, it is necessary to describe the rainfall conditions and the distribution of ragi cultivation prevailing in the Mysore State.

Rainfall.—From a separate statistical study of rainfall of the Mysore State over a period of forty years, from 1893 to 1932, it was found that the mean annual rainfall of the State is 38 inches. Kadur District has the heaviest rainfall (72 inches) and Chitaldrug District, the least annual rainfall (23 inches). The three districts—Hassan, Shimoga and Kadur—lying to the east of the Western Ghats, receive annually more than 40 inches of rain. A narrow strip of land passing through Nagar, Thirthahalli, Sringeri and Mudigere receives heavier rainfall. Agumbi, lying on the edge of the Ghats, receives on an average 317 inches per year.

Ragi Crop.—Three varieties, namely, *Kar* (early season) or Gidda ragi, Irrigated ragi and *Hain* (late season) or Dodda ragi are grown in the State, the particular variety grown depending on the soil and the climatic conditions, particularly the rainfall conditions of the locality. For a

proper study of the factors which influence the growth of ragi, it would be convenient to divide the State into different homogeneous zones where varying systems of agricultural practice are adopted for the cultivation of ragi. Details regarding the distribution of ragi in the State are given in Tables I and II. Of the three varieties, *Hain* or Dodda ragi is grown mainly in the *maidan* (level country) parts of the State. The seeds are sown during July with the help of the first showers of the South-West monsoon. The crop ripens with the help of the North-East monsoon

TABLE I.

The total area, the area under Ragi cultivation, the standard out-turn and the estimated actual yield for each of the districts in the Mysore State (Mean of 10 years 1920–29)

District	Total area of the district	Area under ragi cultivation	% of (2)	Standard out-turn in *pallas* per acre	Estimated actual out-turn in *pallas* per acre	% of (5)
1	2	3	4	5	6	7
Bangalore ..	1969920	456966	23	5·3	2·9	55
Mysore ..	3518720	510081	15	2·1	1·2	57
Tumkur ..	2599040	390525	15	5·5	2·6	47
Hassan ..	1705600	259388	15	4·5	2·6	58
Kolar ..	2034560	294185	14	5·1	2·5	49
Kadur ..	1784320	85663	5	4·8	3·0	65
Chitaldrug ..	2661760	138191	5	4·5	2·3	52
Shimoga ..	2579200	112390	4	2·1	1·1	52
State ..	18853120	2247389	12	4·2	2·3	54

and is ready for harvest when the cold weather sets in. Towards the western and south-western portions of the State, bordering the heavy rainfall zones of the *malnad* (forest

Table II

Table of the variety grown, the area under ragi cultivation, the average estimated actual yield, the standard out-turn for each of the taluks in the Mysore State
(Mean of 10 years 1920–29)

Taluks	Ragi variety H = *Hain* ragi K = *Kar* ragi I = Irrigated ragi	Area under ragi cultivation	Average estimated actual yield	Standard out-turn in *pallas* per acre	Percentage of figures in (4)
1	2	3	4	5	6
Bangalore ..	H	49839	2·94	5·0	52
Hoskote ..	I	29929	2·52	6·0	42
Doddaballapur ..	H	48766	2·22	3·0	55
Nelamangala ..	H	51866	3·25	6·0	54
Kankanahalli ..	H	77989	4·07	8·0	51
Magadi ..	H	66745	2·66	5·0	53
Channapatna ..	H	37358	3·90	6·0	65
Closepet ..	H	38971	2·63	6·0	44
Anekal ..	H	31643	2·00	4·0	50
Devanahalli ..	I	23860	2·53	4·5	56
Bangalore District ..		456966	2·87	5·35	55
Kolar ..	H	35873	2·33	4·0	58
Bowringpet ..	H	31780	3·78	7·0	54
Chintamani ..	H	25649	2·53	4·0	63
Srinivaspur ..	H	26775	3·06	6·0	61
Mulbagal ..	H	27580	1·94	3·0	65
Siddlaghatta ..	I	28036	2·49	4·0	62
Chickballapur ..	I	22289	3·08	5·0	62
Bagèpalli ..	H	19367	2·31	4·0	47
Gudibande ..	H	9266	2·34	5·0	47
Goribidnur ..	I	32844	1·88	4·0	47
Malur ..	I	34786	2·84	5·0	57
Kolar District ..		294185	2·92	5·1	51
Tumkur ..	H	81026	2·12	3·0	71
Madhugiri ..	I	29095	3·58	8·0	45
Koratagere ..	I	23417	2·95	6·0	49
Chicknayakana-halli ..	H	31724	3·03	6·0	51
Sira	I	27752	1·88	5·0	38
Gubbi ..	H	71823	3·34	6·0	56
Tiptur ..	H	36130	1·81	6·0	30

TABLE II—*Contd.*

Taluks	Ragi variety H = *Hain* ragi K = *Kar* ragi I = Irrigated ragi	Area under ragi cultivation	Average estimated actual yield	Standard out-turn in *pallas* per acre	Percentage of figures in (4)
1	2	3	4	5	6
Turuvekere ..	H	26284	2·79	5·0	56
Pavagada ..	I	10407	1·73	4·0	43
Kunigal ..	H	52867	2·36	6·0	39
Tumkur District ..		390525	2·56	5·50	47
Mysore ..	K	35834	0·99	2·0	49
Yedatore ..	H	23643	0·94	1·0	94
Hunsur ..	K	83664	1·09	1·0	109
Heggadadevana-kote ..	K	34443	1·48	3·0	49
Gundlupet ..	H	22648	1·59	3·0	53
Chamarajnagar ..	H	23500	1·02	3·0	34
Nanjangud ..	K	24302	1·43	2·0	72
T. Narasipur ..	K	21499	0·66	1·0	66
Seringapatam ..	H	17645	1·25	1·0	125
Krishnarajpet ..	H	49459	1·16	2·0	58
Nagamangala ..	H	48284	1·43	3·0	48
Mandya ..	H	71921	1·46	3·0	49
Malavalli ..	H	53239	1·22	2·0	41
Mysore District ..		510081	1·21	2·1	57
Hassan ..	K	54869	4·29	6·0	72
Alur	H	11679	2·73	5·0	55
Manjarabad ..	X	1400	0·73	2·0	36
Belur	K	29600	2·42	4·0	61
Arsikere ..	H	41894	2·71	5·0	54
Channarayapatna	H	53771	3·93	7·0	56
Holenarasipur ..	K	30469	1·88	4·0	47
Arakalgud ..	K	35706	1·98	3·0	66
Hassan District ..		259388	2·58	4·5	58
Shimoga ..	H	23630	1·27	2·0	63
Kumsi ..	H	4383	0·50	1·0	50
Channagiri ..	H	43019	2·27	4·0	57
Honnali ..	H	25024	1·86	3·0	62
Shikaripur ..	H	10742	1·02	2·0	51
Sorab	X	4866	0·93	2·0	46

TABLE II—*Conta.*

Taluks	Ragi variety H=*Hain* ragi K=*Kar* ragi I=Irrigated ragi	Area under ragi cultivation	Average estimated actual yield	Standard out-turn in *pallas* per acre	Percentage of figures in (4)
1	2	3	4	5	6
Sagar	X	371	0·62	1·0	62
Nagar	X	325	0·48	1·0	48
Thirthahalli ..	X	30	1·48	3·0	49
Shimoga District ..		112390	1·16	2·1	55
Chickmagalur ..	K	18183	3·51	5·0	70
Kadur ..	H	40046	3·61	9·0	40
Mudigere ..	X	978	3·79	4·0	95
Tarekere ..	H	26223	2·09	5·0	42
Koppa ..	X	144	2·40	3·0	80
Narasimharajapur	X	89	2·48	3·0	83
Kadur District ..		85663	3·00	4·8	63
Chitaldrug ..	H	19016	2·54	5·0	51
Challakere ..	I	9595	4·05	6·0	67
Hiriyur ..	I	8249	1·77	4·0	44
Holalkere ..	H	32202	2·05	4·0	51
Davangere ..	H	29283	1·83	4·0	45
Jagalur ..	I	10859	1·60	3·0	53
Molakalmur ..	I	3150	3·20	6·0	53
Hosadurga ..	H	25837	1·64	4·0	41
Chitaldrug District..		138121	2·33	4·5	51

country) area in Hassan and Mysore Districts, an early variety called the *Kar* ragi is grown. The seeds are sown about the end of April or early in May and harvested in August or September. In the north-eastern portions of the State, the ragi crop is irrigated. This portion of the State is irrigated by springs or *talapariges* or channels drawn from sandy rivers or wells. The growing season is usually the summer months.

The data for the crop is taken from the *Season and Crop Reports* published annually by the Revenue Department. The "Estimated Actual Yield" in *pallas* per acre

given in Tables I and II is the crop estimated at the time of harvest, whereas the "Standard Out-turn" is the yield in *pallas* per acre that is expected under normal conditions.

The total area under ragi cultivation in the State is 2,247,389 acres (average of ten years—1920-29) so that nearly 12% of the total area of the State is under ragi cultivation. Table I gives the average area under ragi cultivation, the total area, the average estimated actual yield and the standard out-turn in *pallas* per acre and the percentage of the estimated actual to the standard out-turn, for each of the districts in the State.

It is seen that the area under ragi in the districts of Shimoga, Kadur and Chitaldrug is negligible, the percentage of the area under ragi cultivation being 5% or less.

The average estimated actual yield of ragi for the State is 2.3 *pallas* or 230 seers per acre, whereas the standard out-turn is 4.2 *pallas* or 420 seers per acre, indicating that the yield in general is underestimated unless it be that the standard out-turn is overestimated.

The details of these statistics and the particular variety grown (*viz.*, *Hain* or Dodda ragi, Irrigated ragi and *Kar* ragi) in each of the taluks in the State are given in Table II. The table indicates that the quantity of ragi grown in the taluks of Sorab, Sagar, Nagar and Thirthahalli in Shimoga District, Mudigere, Koppa and Narasimharajapur in Kadur District and Manjarabad in Hassan District, is practically negligible.

Part I. Bangalore District

The ragi yields of Bangalore District which has 23% of the area under ragi cultivation are first examined in relation to rainfall and temperature. Of the three varieties, *Hain* or Dodda ragi is grown in this District, the growing period of which is from July to November. Table III gives the estimated actual yield per acre, the monthly rainfall and the monthly mean daily dry temperature during the growing

TABLE III

Estimated actual yield, monthly rainfall and the monthly mean daily dry temperature for Bangalore District

Year	Yield in pallas per acre	Rainfall in inches						Monthly mean daily dry temperature in °F.					
		July	August	Sep.	Oct.	Nov.	Total	July	August	Sep.	Oct.	Nov.	Mean
1904	1·1	4·2	1·6	5·3	4·8	0·1	16·0	71·9	73·1	73·6	73·3	69·6	72·3
05	2·3	2·5	6·3	2·3	5·1	1·1	17·3	74·3	73·9	74·1	72·5	70·8	73·1
06	3·4	5·1	11·7	5·4	9·6	0·5	32·3	73·5	72·6	71·9	72·4	71·3	72·3
07	2·4	4·2	1·5	5·7	1·9	1·4	14·7	73·5	72·0	73·9	73·7	70·7	72·8
08	2·1	2·7	2·7	4·3	2·2	0·1	12·0	71·7	72·9	74·2	73·7	70·2	72·5
09	2·7	2·0	13·6	5·6	7·0	1·4	29·6	72·4	73·7	72·5	73·4	72·1	72·8
1910	3·3	9·9	7·1	4·2	10·6	4·5	36·3	74·1	72·2	71·3	72·1	68·1	71·6
11	2·7	3·3	1·6	2·7	7·8	1·5	16·9	73·3	73·6	75·9	73·6	72·2	73·7
12	3·5	3·5	6·1	10·8	8·9	1·7	31·0	73·6	73·9	74·5	73·2	75·5	73·1
13	2·3	3·6	1·3	9·2	4·1	0·1	18·3	73·1	74·1	75·8	73·3	71·4	73·5
14	3·5	2·0	3·8	4·9	5·7	2·0	18·4	74·1	73·7	75·4	73·7	71·7	73·7
15	3·8	3·5	1·8	7·5	4·4	3·4	20·6	75·3	75·6	75·3	75·2	72·2	74·7
16	3·8	7·4	7·2	4·7	7·0	5·9	32·2	74·8	73·4	73·6	73·2	70·8	73·2
17	3·7	1·0	6·4	11·2	4·5	2·5	25·6	75·4	74·1	73·5	72·2	71·8	73·4
18	1·9	1·4	2·5	4·8	1·0	4·9	14·6	75·9	74·5	74·7	76·0	73·5	74·9
19	3·2	4·6	2·1	11·9	1·9	5·7	26·2	74·4	74·1	74·9	74·7	71·6	73·9
1920	3·1	1·1	4·1	6·3	3·0	1·9	16·4	74·8	74·4	74·6	74·4	72·0	74·0
21	3·1	4·0	6·3	3·0	5·2	2·4	20·9	74·6	74·3	73·1	73·6	70·1	73·1
22	3·2	1·7	3·5	2·3	9·8	5·4	22·7	73·8	74·0	74·5	73·3	71·1	73·3
23	2·8	2·3	1·6	6·3	1·9	0·1	12·2	72·5	73·7	73·6	74·6	73·7	73·6
24	3·8	3·9	4·2	6·3	2·3	2·2	18·9	73·6	74·2	74·4	74·7	71·8	73·7
25	2·5	2·2	3·5	6·0	1·3	1·8	14·8	74·2	74·1	75·6	74·0	71·5	73·9
26	2·3	1·5	2·1	8·2	4·8	0·1	16·7	76·1	74·9	74·5	74·7	72·6	74·6
27	2·4	3·5	3·6	10·3	0·5	1·6	19·5	73·2	74·7	75·1	74·4	71·5	73·8
28	3·0	5·0	4·7	0·8	9·9	1·5	21·9	74·4	73·5	75·8	74·3	72·3	74·1
29	3·6	1·3	1·4	6·3	6·5	3·5	19·0	75·7	76·2	75·9	74·2	71·8	74·8
1930	4·2	2·4	1·5	5·9	9·6	1·7	21·9	75·0	75·3	75·2	73·8	71·4	74·1
31	2·5	2·4	0·9	7·9	1·2	3·7	16·1	75·9	75·7	74·5	75·2	72·2	74·7
32	3·9	2·3	7·0	3·4	9·6	4·4	26·7	74·3	75·8	74·2	74·6	72·4	74·3
Standard Deviation (σ)	0·72	1·9	3·0	2·7	3·1	1·7	6·4	1·2	1·0	1·1	0·9	1·0	0·82
Coefficient of Variability (V) ..	23	58	71	45	60	74	30	1·6	1·4	1·5	1·2	1·4	1·1

period for 29 years from 1904 to 1932 both inclusive. The mean standard deviation and the coefficient of variability for each of the elements are also given.

Variability.—The standard deviation (σ) gives an idea of the distribution of these about their mean values (M). For purposes of comparison of these distributions, the coefficient of variability (V) obtained from $\frac{\sigma \times 100}{M}$ is also given. The variability is maximum for rainfall, that of September being least variable (45%) and that of November being most variable (74%). The variability is minimum for temperature, that for July being the highest (1.6%) and that for September being the least (1.2%). The variability of the yield is 2.3%, the average yield per acre being 3.0 *pallas* or 300 seers.

Total Correlations between the Yield, Temperature and Rainfall.—Total correlations between the yield, mean daily dry temperature and the rainfall of the individual months are given in Table IV. The significance of the coefficients has been tested before conclusions were drawn from them. A coefficient is considered as significant if P, the probability of exceeding the observed value through random sampling, is less than 0.5. According to Prof. Fisher, the coefficient for 30 degrees of freedom and 5% level of significance is 0.3494.

Applying Fisher's test, it is seen that ragi yield is significantly correlated with rainfall during the complete growing season; but considering the months separately, only October and November rainfalls are significantly correlated with the yield of ragi.

The correlation between the mean daily dry temperature during the complete growing season and the yield is not significant. However, the correlations between the temperature in July and August together and the yield are on the verge of significance, which indicates that the temperature in the early growing period may considerably influence the yield of ragi.

Table IV

Total correlation coefficients between the yield, monthly mean daily dry temperature and the rainfall of the individual months and two combinations of the months

Correlation between	July	August	September	October	November	July to November	July and August
Rain (r) and yield (y) ..	+ 0·123	+ 0·273	+ 0·068	+ 0·491	+ 0·400	+ 0·537	+ 0·261
Temperature (t) and yield (y) ..	+ 0·349	+ 0·301	− 0·013	− 0·101	+ 0·040	+ 0·171	+ 0·367
Temperature (t) and rain (r) ..	− 0·189	− 0·317	+ 0·114	− 0·503	− 0·086	− 0·400	− 0·325

Table V

Partial correlation coefficients between yield, temperature and rainfall.

Partial correlation between	July	August	September	October	November	July to November	July and August
Rain and yield ($R_{ry.t}$) ..	+ 0·206	+ 0·409	+ 0·069	+ 0·511	+ 0·400	+ 0·672	+ 0·461
Temperature and yield ($R_{ty.r}$) ..	+ 0·383	+ 0·426	− 0·021	+ 0·195	+ 0·081	+ 0·500	+ 0·525

Partial Correlation Coefficients.—As the monthly rainfall and the monthly mean daily dry temperature are themselves related to each other to some extent, partial correlation coefficients between yield and rainfall when the temperature variations are eliminated ($R_{ry \cdot t}$) and between yield and temperature when the rainfall variations are eliminated ($R_{ty \cdot r}$), have been determined. These correlation coefficients have also been tested for significance. The total correlations between rainfall and temperature as expected are negative excepting that of September which is positive but too small to be significant. The effect of these negative correlations is to raise the partial correlations higher than the respective total correlations.

The correlations between rainfall and temperature in the early months, *viz.,* July and August, and the ragi yield are high; this indicates that the ragi yield is controlled or influenced by conditions of rainfall and temperature in the early period of the growth of the plants. Hence the possibility and the utility of forecasting the yield of ragi by the end of August from weather factors is established.

Regression Equation for Forecasting the Yield of Ragi by the End of August.—Considering the first two months, July and August together, the Partial Correlation Coefficients $R_{ry \cdot t}$ and $R_{yt \cdot r}$ are + 0.467 and + 0.525 respectively. The regression equation for forecasting Y, the yield at harvest is,

$$Y = 3{\cdot}0 + 0{\cdot}085\ (R - 7{\cdot}5) + 0{\cdot}407\ (T - 74{\cdot}1),$$

where Y = Ragi yield in *pallas* per acre,
T = Mean daily dry temperature for July and August together in degrees F., and
R = Rainfall in July and August in inches.

The yields calculated by applying the formula given above for the period 1904 to 1932, along with the actual yields and the differences between them are given in Table VI.

Table VI

Table of the calculated and the actual yields of ragi

Year	Calculated yield in pallas per acre	Actual yield per acre	Difference in pallas per acre
1904	2·2	1·1	+ 1·1
05	3·1	2·3	+ 0·8
06	3·4	3·4	0·0
07	2·3	2·4	− 0·1
08	2·1	2·1	0·0
09	3·3	2·7	+ 0·6
1910	3·4	3·3	+ 0·1
11	2·5	2·7	− 0·2
12	3·0	3·5	− 0·5
13	2·6	2·3	+ 0·3
14	2·8	3·5	− 0·7
15	3·3	3·8	− 0·5
16	3·6	3·8	− 0·2
17	3·2	3·7	− 0·5
18	3·1	1·9	+ 1·2
19	2·9	3·2	− 0·3
1920	3·0	3·1	− 0·1
21	3·4	3·1	+ 0·3
22	2·7	3·2	− 0·5
23	2·3	2·8	− 0·5
24	3·0	3·8	− 0·8
25	2·9	2·5	+ 0·4
26	3·2	2·3	+ 0·9
27	2·9	2·4	+ 0·5
28	3·1	3·0	+ 0·1
29	3·2	3·6	− 0·4
1930	3·1	4·2	− 1·1
31	3·3	2·5	+ 0·8
32	3·6	3·9	− 0·3

The accuracy of the forecasting formula would gradually increase as the limitations are gradually diminished. Among the limitations, the more important ones are:—

(1) consideration of the yield data based on eye estimate, instead of data from experimental farms, or crop cutting experiments,

(2) consideration of the Micro-Climatic or the usual meteorological data instead of the Micro-Climatic or the weather factors actually experienced by the plants,

(3) consideration of the usual calendar months which are too long instead of shorter periods based on the Agricultural Meteorological Calendar such as the one developed by Sir Napier Shaw, and

(4) consideration of the actual rainfall instead of the effective rainfall.

In conclusion, I wish to express my gratitude to the then Director of Agriculture, Dr. B. Narasimha Iyengar, for suggesting this statistical study and the encouragement given by him and to Dr. L. A. Ramdas, Agricultural Meteorologist, Poona, for his criticisms.

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The Eighteenth Annual Report

GENTLEMEN,

The Committee of Management have great pleasure to welcome you to the Eighteenth Annual General Meeting of the Mysore Agricultural and Experimental Union and to submit the Annual Report for the 15 months ending 30th June 1937.

Before proceeding to give an account of the progress

of the Union's work during the last 15 months, it is our painful duty to record the sad demise of two of the most valued foundation members of the Union. Mr. Badami Krishna Rao passed away after a brief illness on the 11th June 1937, at the ripe age of 87. Mr. Krishna Rao's experience of village life and agricultural practices was profound. He was not only an able observer but a careful recorder of his observations. The *Villagers' Calendar* which he published for some years, at his own cost, served as the model when the Agricultural Department decided to bring out an Annual Agricultural Calendar in 1915. Mr. Krishna Rao's great agricultural experience and practical outlook were very helpful in organising the Union on its present basis in 1917.

By the equally sad demise early this year of Mr. Srinivasa Rao of Hongenahalli, Kolar District, the Union lost one of its most prominent foundation members. Mr. Srinivasa Rao served on our Managing Committee without a break since the formation of the Union. He was our Vice-President for over six years. Mr. Srinivasa Rao brought to his work a rare scientific attitude of mind and critical outlook. His *Notes on the Cattle of Mysore* will ever remain a monument of research on the subject of Mysore cattle involving as it did, a careful collection of facts, correct interpretation and clear statement. It may not be generally known that when we read Pearce's *Mysore Cattle,* we are reading Mr. Srinivasa Rao's *Notes on Mysore Cattle* in slightly revised form, unfortunately without reference to his name.

Mr. Srinivasa Rao's interests were very wide. He was one of our few members who always took active part in the experimental programme of the Union. He spent much time and care on the conduct of experiments and sent reports which are models of their kind. The scope of his experimental work was wide enough to include practically all the varied activities of the Department itself. Experiments on the control of the cocoanut beetle, trial of improved varieties of crops like ragi, groundnuts, sugarcane and castor, trial

of imported ploughs in comparison with indigenous and locally manufactured iron ploughs, soil improvement studies, tank and well irrigation problems, bore-wells and pumping outfits, economic studies concerning costs of living of agricultural classes—these are the many and varied subjects which he studied with his usual care and scientific diligence. Speaking about his work, Dr. Coleman said in 1922: "Mr. Srinivasa Rao has been, from the first, one of our active members. He is a man who, after an active life in one of the most strenuous departments of Government Service, has gone back to the land and is in personal management of his large estate in Malur Taluk. He has been most painstaking in testing our improved plough and has furnished us with a most valuable report and opinion upon it. He has been instrumental in the popularization of the use of Ammonium Sulphate for sugarcane, while his investigations of a serious pest of the cocoanut have been very valuable. He has also carried out regular tests on both ragi and groundnut varieties. Whenever Mr. Srinivasa Rao takes up a piece of work, I am always perfectly sure that he will carry it out in a thorough and scientific manner and I look upon him as a sure and steady support to the structure of improved agriculture which we are trying to erect in the State."

Turning to the activities of the Union, it is scarcely necessary to repeat year after year the main purpose for which the Union was founded. The most important function of the Union is to conduct tests of improvements recommended by the Agricultural Department with a view to finding out how far these are real improvements under the varied soil and climatic conditions of the State. From the statement attached, it will be seen that this most important work is not receiving the attention it deserves. The work of the Union in the past indicates conclusively that no suggested improvement is an improvement under all conditions. Every recommendation before being adopted has, therefore, to be tested in a correct manner on a small scale over two or three seasons. If all these are facts, why is it

then that the work is not receiving sufficient attention? The conditions necessary for the progress of testing of improvements on ryots' land are as follows:—

1. There must be recommendations made as the result of research in the laboratory and on the Experimental Farm requiring to be tested for their applicability with reference to local conditions.

2. There must be an informed demonstration staff in the Agricultural Department which will interest the agriculturists in the improvements and persuade the more advanced among them to test the improvements on a small scale and help them in laying out tests and collecting and recording results accurately.

3. There must be a sufficient number of intelligent agriculturists who can realise the need for careful preliminary testing and the small amount of loss involved in the process, because what is not an improvement cannot be more profitable than the useful practice and the discovery of the fact has to be paid for.

In Mysore, at any rate, the conditions favourable for the development of testing of improvements on ryots' lands do apparently exist. The Agricultural Department, as the result of research conducted over 30 years, have accumulated a fund of accurate knowledge which await application to agricultural practice. There is a trained staff which has the duty of carrying the results of research to the field, entrusted to it. There are many prominent agriculturists who are quite capable of conducting small field trials and who are, at the same time, alive to the need of conducting them and are prepared to make the small sacrifices inherent in such work. The Agricultural Department recognises that before improvements are recommended on a large scale, correct testing under varied conditions of the State is necessary. With the concurrence of Government, they have been supplying material for experiment free. Due to the heavy cost involved, they have not been able in recent years, to supply manures intended for trial free. The Department

gives the assistance of trained staff for laying out trial plots and collecting results at harvest time. They want accurate information as to the extent to which their recommendations have benefited the ryot. The work of the Union in the past has been of great value to the Department in its extension work. The Department wants more of such work. Such being the case, how can the slackening of interest in this work be explained? The number of persons undertaking work is decreasing; so also the number of experiments undertaken. Having received material for experiment, members have sometimes not conducted the tests at all, or having started the test, have neglected it, or have mixed up varieties at harvest, or having conducted the work to a successful finish, have not reported the results. All this is very discouraging. This Union can justify itself only on its programme of work. It cannot, like other agricultural associations of the past, live a moribund existence. Members must decide now what they will do in the immediate future.

Turning now to the other most important function which the Union has taken up itself, *viz.*, the dissemination of accurate agricultural information, it must be said that there is considerable slackening of interest there also. The greater part of information to be published must be the result of research by the Agricultural Department. But there is a kind of information which only the person who is actively engaged in farming can provide. The achievements or disappointments of the farmers, whether the farmers are making anything out of their profession, which item of their farming is profitable and which accounts for the loss or lowered income, agricultural practices which they have found to be efficient or inefficient, these and many other questions can be answered only by the farmers themselves. Before starting upon improving conditions, one must have correct data as to the present conditions. Our members can supply information in this direction. The Journals are expected to give special prominence to tested experience. Our members who are engaged in the

farming profession can render valuable help to the Department by accurately testing departmental recommendations and sending report of results for publication. It must be admitted however that good printable matter supported by local investigation and experience is sadly lacking. The Editor cannot produce information of this kind from somewhere. As long as his hands are not strengthened by everybody concerned sharing his responsibility to some extent at least, the Journals cannot be published regularly. We are some three numbers behind as regards the English Journal and two issues behind in Kannada. This by itself is not a very alarming situation, but should present conditions continue, the position of those responsible for publication of the Journals becomes embarrassing.

The statement attached indicates a very alarming state of affairs as regards the paying circulation of both the English and Kannada editions of the Journal. The English Journal has a circulation of 111, which brings us Rs. 333 per annum. The expenditure upon it is annually about Rs. 600, excluding expenses on establishment and other contingent expenditure. The Kannada Journal has a circulation of 142, which brings an annual income of Rs. 426. The expenses of printing it amount on an average to Rs. 720. We lose on the printing of these two Journals Rs. 561. The minimum establishment which is being maintained for this work costs Rs. 1,632 annually. There are other expenses to be met as can be seen from the Statement of Receipts and Expenditure attached. Government have sanctioned a reduced annual subvention of Rs. 2,000 for two years now. Our total estimated expenditure per annum is about Rs. 3,500. We fall short of about Rs. 740 annually under present conditions. While it is necessary for the Union to make every effort to increase the number of subscribers to the Journal, it is very desirable that the facts are brought to the kind attention of Government with a view to obtaining the full amount of subvention which they were pleased to grant in previous years.

Looking at the details of paying circulation, it is seen that the subscription for the Kannada Journal is steadily falling. The Village Panchayats who should be our main supporters are keeping away. Unless the Revenue Authorities come to our rescue and induce as many Panchayats as possible to subscribe to the Journal, we cannot hope for much improvement in circulation. It must be clearly stated for the information of all concerned that the Union is not out to make profits. It is there to be of service to the agricultural population. If the circulation of the Kannada Journal can be increased to 3,500 by either Government purchasing that number of copies for supply to Village Panchayats, or inducing them effectively to do so, it would be possible to reduce the annual subscription by half, *i.e.,* Rs. 1–8–0, in addition to improving the illustrations side of it even more than now.

The Department of Public Instruction have recently taken further steps to popularise the Kannada Journal among the Middle Schools in rural areas. There is a hope that in the immediate future, the subscriptions from Schools might increase. It must be pointed out, however, that our members can do a great deal in popularising the Journal in their neighbourhood. Without increasing expenditure by a single rupee, it is possible to increase subscription by ~~Rs.~~ 300. This means Rs. 900, a very substantial increase of income.

A word must be said about our General Meeting. In the past, it was customary to hold the annual meetings early in November (well before the beginning of harvest) every year so as to attract as many members as possible. Everybody knows that our meetings were well attended in those days. Change of months decidedly affected attendance adversely. It would be better to decide upon a suitable month for the Annual Meeting and Field Day with a view to reviving interest in the Union among members.

Statements showing receipt and expenditure, experimental work undertaken by members and circulation of Journals are attached.

Before closing, it is necessary to refer to an event of importance to the Union. Its President Dr. B. Narasimha Iyengar, Director of Agriculture, retired from Public Service after a distinguished service of nearly 32 years. He has been closely connected with the management of the Union since his return from Germany in 1919. He was Chief Editor of the Journal for nearly 16 years and President since March 1935. In all these capacities Dr. B. Narasimha Iyengar has done yeoman service to the Union. It is the pleasant duty of the Management to record their appreciation of the very valuable services rendered by him to the Union.

N. VENKATSUBBAYA,
Secretary.

10–7–1937.

Statement of Receipts and Expenditure from 21–3–1936 to the end of 30–6–1937

RECEIPTS

	Rs.	A.	P.
Opening Balance on 20–3–1936	1,346	3	7
Admission fee	45	0	0
Membership fee	297	8	0
Subscription only	469	12	0
Miscellaneous	104	8	9
Subvention for 1936–37	2,500	0	0
GRAND TOTAL ..	4,763	0	4

LIABILITIES.

		Rs.	A.	P.
1.	Press bills pending payment	79	2	0
2.	Establishment for the month of June 1937	136	0	0
3.	Cost of printing May & June issues of Kannada Journal	120	0	0
4.	Cost of printing Vol. XVI, No. 4 of English Journal	150	0	0
5.	Cost of printing two more numbers of English Journal upto end of June	300	0	0
6.	Contingencies (Postage, etc.)	50	0	0
	TOTAL ...	835	2	0

EXPENDITURE.

	Rs.	A.	P.
Establishment for 15th months	2,016	13	4
Press bills paid	1,556	6	0
Stamps (Postage)	76	8	0
Annual Meeting and Field Day for 1936 ..	254	7	6
Miscellaneous (Contingencies)	35	11	3
TOTAL ..	3,939	14	1
Cash on hand	823	2	3
GRAND TOTAL ..	4,763	0	4

N. VENKATSUBBAYA,
Secretary.

Proceedings of the Eighteenth General Meeting, held at the Hebbal Farm on 10th July 1937

The Annual General Meeting of the Mysore Agricultural and Experimental Union was held on the Hebbal Farm on the 10th July 1937. About 45 members were present. In the absence of the President, Mr. B. Venkatanaranappa, the Vice-President, presided. In his opening remarks the Vice-President referred to the letter of resignation sent in by the President Dr. B. Narasimha Iyengar on the eve of his retirement as Director of Agriculture. The Vice-President moved from the Chair the following resolution which was passed *nem con*:—

"This meeting of the Members of the Mysore Agricultural and Experimental Union desires to place on record the valuable services rendered by Dr. B. Narasimha Iyengar, B.A., PH.D., to the Union in the capacity of Chief Editor of the Journal and President of the Union."

The Vice-President then referred to the sad demise of Messrs. H. Srinivasa Rao and Badami Krishna Rao both of whom had evinced keen interest in the work of the Union. He moved the following resolution which was passed in silence, the members standing:—

"This meeting of the Members of the Mysore Agricultural and Experimental Union desires to express their sense

of sorrow at the demise of two of their oldest foundation members, Messrs. H. Srinivasa Rao and Badami Krishna Rao and places on record the invaluable services rendered by them, in different capacities, to the cause of Agricultural Improvement in the State."

Briefly explaining the need for revising the rules, the Vice-President then drew the attention of the members to the decrease in the number of the members and subscribers to the Journal and the diminishing interest in the experimental work and requested the members to take greater interest in the work of the Union.

Alluding to the interest and enthusiasm of the present Director of Agriculture in agricultural improvement, the Vice-President appealed to him and the Department to strengthen the Union by enlisting members and subscribers and organising experimental work on a larger scale.

The Secretary then read the Annual Report (published on page 86). Mr. N. Krishniengar moved and Mr. Gopalasami Iyer seconded the adoption of the report and statement of accounts. They were adopted unanimously.

The Vice-President read the constitution and rules of the Union (published elsewhere in this issue) as amended by the Committee appointed for the purpose. The amended constitution and rules were then passed unanimously.

The elections were then held. The following members were elected to the Managing Committee and the Board of Editors respectively.

Members of the Managing Committee:—

1. Dr. V. K. Badami.
2. Mr. M. J. Narasimhan.
3. Mr. B. Shankara Rao Badami.
4. Mr. M. S. Ramachandra Rao.
5. Mr. G. Venkataramaniah.
6. Major C. B. Oakley.
7. Mr. T. S. Raghavachar.
8. Mr. S. Lakshmana Reddy.
9. Mr. Hanumegowda.

Memebers of the Editoiral Committee:—(*vide* cover page 3.)

After according a hearty vote of thanks to the Vice-President the function terminated.

Constitution and Rules of the Mysore Agricultural and Experimental Union, Bangalore

Name.—The name of the Association shall be **"The Mysore Agricultural and Experimental Union".**

Objects.—The objects of the Union shall be:—

1. To create and foster a feeling of unity of interest among the members.
2. To exchange ideas with a view to improve the stock of scientific knowledge and to further the development of agriculture in the Mysore State.

Motto.—The Motto shall be in Sanskrit—*Krishitho Nāsthi Durbhiksham* (ಕೃಷಿತೋ ನಾಸ್ತಿ ದುರ್ಭಿಕ್ಷಂ) —which means that "Agriculture knows no starvation".

Headquarters.—The Headquarters of the Union shall be Bangalore.

Constitution.—The membership of the Union shall be open—

(1) To all those that have received training in some recognised Agricultural Institution.

(2) To the members of the staff of the Agricultural Department: and

(3) To all agriculturists and such others as are interested in the development of agriculture in the State, provided that the approval of the Committee of Management is obtained for admission in each case.

The management of the Union shall be vested in a Committee consisting of a President, a Vice-President, a Secretary and nine other Members, all to be elected annually by the General Body of the Union. Provided, however, that so long as the Government appoints a Secretary to manage the affairs of the Union, this rule, in so far as it relates to the election of the Secretary, shall not be operative.

Subscription.—Every applicant for admission shall pay an entrance fee of Re. 1, and an annual subscription from July to June, of Rs. 3, which shall be payable in advance. Persons who are in arrears of their subscription for two years consecutively shall cease

to be members, but it shall be open to them to revive their membership on payment of their dues and a re-admission fee of Re. 1.

Application for membership shall be made on forms which may be had from the Secretary.

Associates.—Students in residence at the Hebbal Agricultural School may be admitted by the Committee as Associates of the Union without payment of any fee, but they shall have no voice in the management of the Union.

The Committee of Management.—The Committee of Management shall be responsible for the proper working of the Union. It shall meet as often as may be necessary for the transaction of business. There shall be not less than four Committee Meetings per year. Five members shall form a quorum. If business cannot be transacted at a Committee Meeting for lack of a quorum, the meeting shall be adjourned to a subsequent date of which due notice shall be given to all the members. The adjourned meeting shall transact the business notified in the original meeting, irrespective of whether there is a quorum or not. Casual vacancies in the Committee shall be filled up by the remaining members of the Committee. The Committee shall have power to co-opt not more than three other members.

A standing Sub-Committee consisting of the President, the Vice-President, the Secretary and two Members elected by the General Committee from among themselves shall be formed to attend to routine work. Three shall form a quorum.

The Editorial Board.—There shall be an Editorial Board for conducting the English and the Kannada Journals of the Union. It shall consist of twelve members of the Union elected once in three years by the General Body of the Union. The Board shall appoint one of its members as the Chief Editor of the English Journal, and another of its members as the Chief Editor of the Kannada Journal. The Secretary of the Union shall be the *ex-officio* Secretary to the Board. Casual vacancies in the Board may be filled up by the remaining members. The Board shall have power to co-opt not more than three persons who may or may not be members of the Union.

Functions of the Office-bearers.—The President shall preside at all the meetings of the Committee and of the General Body. He shall have power to call extraordinary or special meetings of the Committee or of the General Body, either on his own initiative or on a written requisition from not less than one-fourth of the total number of members in the case of the Committee Meetings, and of not less than twenty members in the case of the General Body Meetings, clearly specifying the subject or subjects for discussion at such meetings.

The Extraordinary or Special Meetings requisitioned for by members shall be convened within a fortnight of the date of receipt of the application. In cases of urgency, the President shall have power to take such action as he may deem necessary, without consulting the Committee, which should be informed of such action at the earliest opportunity.

The Vice-President shall perform all the functions of the President during his absence, or such other duties as may be delegated to him by the President from time to time.

The Secretary shall manage all the correspondence of the Union and shall have charge of all its records. He shall be responsible for their proper maintenance and preservation. He shall enter the minutes of all meetings of the Union in a book kept specially for the purpose, separate books being maintained for the Meetings of the Committee and of the General Body. He shall convene all the meetings of the Union under the direction of the President. In the case of Committee Meetings, at least three clear days' notice and in the case of General Body Meetings, at least a clear fortnight's notice shall be given to the members. The Secretary shall be in charge of the finance of the Union under the control of the President and shall collect subscriptions, grant receipts and keep an accurate account of all receipts and expenditure.

General Meetings.—There shall be an Annual General Meeting of the members of the Union, at which the Secretary shall present the Annual Report of the Union for adoption by the General Body. At this Meeting, notified elections shall be held, the out-going members being eligible for re-election. Members who are in arrears with regard to their subscription shall not be eligible to stand for election and shall not have the power of voting. At any General Meeting, papers giving the results of work done by the members may be read, provided that they have been previously approved by the Committee of Management.

Members who desire to read papers or to bring up subjects for discussion at the General Meetings of the Union, shall send in their papers or the subjects to the Secretary at least a week previous to the meeting.

One-third of the number of members on the rolls or twenty members, whichever is less, shall form the quorum.

Dissolution.—The Union shall not be dissolved unless three-fourths of the total number of members on the rolls vote its dissolution at two consecutive meetings.

SELECTIONS

The Curing of Cashew Nuts for Export

In South India the cashew nut industry is well organised and a fairly considerable trade in the commodity has already been established with the U.S.A. and Europe. The preparatory methods of curing adopted there is, however, crude, leaving much room for improvement. In this connection we are dealing below some of the best improved methods successfully experimented in the chemical laboratory of the Department of Agriculture, Ceylon.

The process of curing is carried out in several stages, *viz.*, (1) roasting, (2) shelling, (3) removal of inner coat, (4) grading and (5) packing.

Roasting.—The cashew nut has a very tough pericarp or shell which contains a kind of caustic oil and makes the shelling of the nut a troublesome process. In order to remove this oil partially making less caustic to the skin and to render the nuts brittle, these are subjected to the roasting process which is severally carried out in open iron pans placed over a small circular earthenware furnace. Small quantities of nuts are treated at a time and the period of roasting is not more than a minute. The rinds of the previously shelled nuts serve as fuel. Great care is taken to see that the nuts are not over-roasted, the kernels would be turned brown and thus rendered the nuts unsaleable abroad. Excessive roasting is prevented by sprinkling water on to the pans to reduce the fumes.

Shelling.—The roasted nuts are next shelled. This is a very skilled operation and is done in South India by means of a sort of wooden mallet. Great care is required in this operation to reduce kernel breakages to a minimum. After breaking the shells the kernels are removed with a wire prong for their caustic properties.

Removal of Inner Coat.—It is essential for export purposes to remove the pink to reddish brown inner coat. This is usually done by spreading the nuts on wire gauze trays in hot air rooms under controlled temperatures. Heating at a temperature of about 120°F. for 3 hours is generally found to be best under Indian conditions.

As this optimum temperature will vary with the climatic conditions and the nature of the nuts, it is not surprising to note that under local conditions a temperature of about 155°F. has been found more favourable. At higher temperatures the kernels become too brittle. The drying of the kernels, besides removing the inner coat, removes any excess moisture in them and thus prevents the tendency to mouldiness in storage. The seed coat is removed soon

after the kernels are taken out of the oven. This operation is also done by hand. Delay in peeling renders the process more difficult. After peeling, the kernels are spread on the floors indoors, when they absorb some moisture and become less brittle.

Grading.—Cashew nuts are generally graded into (1) wholes or completed kernels, (2) halves consisting of one cotyledon only, (3) brokens, the broken kernels and (4) rejects or spoilts. Only grades (1) and (2) are exported abroad, but the latter fetch much lower prices than the wholes. The brokens and rejects are utilised locally in various ways.

Packing.—The well-dried, graded kernels are finally packed in 25 lb. tins. The nuts were until recently filled into the tins which were then charged with carbon dioxide gas and sealed. This practice has now been given up as being objected by buyers. The filled tins are, instead, vacuumised through a small whole in the lid, which is then hermetically sealed.

Industry, Vol. XXVIII, No. 330.

Tobacco Fertilizers

Growers of bright-leaf, flue-cured tobacco in the South-Eastern States have a delicate fertilizer problem in their efforts to get good yields and to keep their bright tobacco bright. The tobacco fertilizer analyses found best in recent years are: (1) for heavy productive soils, 3 per cent. nitrogen, 10 per cent. available phosphoric acid and 6 per cent. potash, applied 700 to 800 pounds per acre; (2) for light, less productive soils, a 3-8-6 analysis, 800 to 1,000 pounds per acre.

Tests at South Carolina's Pee Dee Experiment Station in 1934 indicate the importance of a liberal supply of potash in the fertilizer mixture. The plots which received the normal supply of nitrogen and phosphoric acid, but no potash, showed the usual characteristic symptoms of potash hunger. The leaves were somewhat drawn and rough, showing mottled discolorations and coppery specks at the tips and around the margins. The leaves curved downward towards the under side. The specks later enlarged, forming dead areas between the veins and giving the plant a rusty brown appearance. In practically all cases where potash was left out or the supply in the mixture was limited, the yield was reduced and the quality of leaf was very poor.

One thousand pounds per acre of a 3-8-9, with two per cent. of the potash derived from muriate of potash, and the balance from sulphate

of potash, produced a good yield and a high grade of leaf during the 1934 season. Higher rates of potash, such as the 3-8-15 and 3-8-21, at the same rate per acre and carrying the usual two per cent. chlorine, did not produce in much of the red coloured leaf in the cured product as in previous years. This may have been due partly to the extremely dry weather during the growing season.

An interesting new light on fertilizing tobacco shows where fertilizer is best placed with reference to the tobacco plant. In some tests conducted last season, fertilizer mixtures were applied separately by a combination of transplantater and fertilizer distributor which makes it possible to apply the mixture at the desired distance to either the side of or underneath the root crown of the plant. The best stand of tobacco was obtained where the fertilizer was placed 2½ inches to the side of the root crown at the time of transplanting. The poorest stand resulted where the fertilizer was mixed with the soil around the plant. Mixtures placed directly below the root crown of the plant gave comparatively poor stands. The side placements not only resulted in better stands, but the plants grew off much faster and more evenly and uniformly than with any of the other placements.

Another serious of tobacco fertilizer problem is the injury to the colour and quality of the product caused by the presence of too much chlorine and sulfer in the fertilizer mixtures.

Experimental data and practical experience are showing that while a small quantity of chlorine in the tobacco fertilizer increases the acre value of the crop, an excessive amount not only injures the growth but also reduces the quality by producing a thick, brittle leaf which, when cured, becomes thin, saggy and dull in colour, and also produces an unfavourable effect on burning quality. Trial-and-error results indicate, and tobacco specialists and agronomists therefore recommend, that fertilizer mixtures should contain not over two per cent. of chlorine.

So too sulfur, results show that maturity of the crop is delayed and color of leaves is too red when there is much sulfur in the fertilizer. Hence the advice that fertilizers be formulated to contain a minimum of sulfur, preferably by reducing the soluble sulfur compounds used in the fertilizers.

To control sand-drown, or magnesia hunger, it seems desirable to have in the fertilizers two per cent. magnesia (MgO), half of which should be water-soluble or come from water-soluble materials.

—*Better Crops with Plant Food,* February–March 1935.

Cotton Breeding in India

For perhaps 4,000 years India took first rank among the cotton countries of the world. Throughout this period the crop was grown extensively and converted into sufficient quantities of cloth and various other fabrics to meet domestic needs and in addition to supply traders who carried Indian products to foreign countries.

Indian textile work was done, as much of it still is to-day, with hand-operated equipment, which is very crude and primitive. Doubtless much of the product consisted of coarsely fabricated cloths, cordage, strings, and other textile-like materials. However, the native artisans were able to weave muslins of such delicate texture that they have never been equalled in fineness, and the garments made from these cloths were sometimes referred to as "webs of woven wind".

The native cotton of India, so far as is known, has always been very short in staple length, often one-half inch and less. However, it is possible that some sort of fine or long-staple kinds of cotton were cultivated in that period but later became extinct. After the industrial revolution, the modern mill could not duplicate the fine work of the artisans of India with the short cotton. The advent of the machine stimulated the demand for cotton with more length and a more uniform quality in general. The factory interests turned to the United States for most of their raw materials—sea island cotton for the finest yarns, and upland for the general run of goods—until the cotton famine of the American Civil War, when they resorted to other countries temporarily. This situation again stimulated the cotton-growing industry in India as well as in all countries where there was a possibility of expansion. The final result has been the marked increase in foreign production in recent years.

India now is second in production to the United States and produced during the ten-year period 1924–25 to 1933–34, an average of 4,448,000 bales of 478 pounds, or 16.92 per cent. of the world crop. The trend has been distinctly upward for the past 35 years. Two things have made it possible for the manufacturer to utilize increasing quantities of Indian cotton: (1) The quality of the Indian crop has been improved by bringing in exotic kinds and by breeding, and (2) mill machinery has been adapted as much as possible to the utilization of a much higher percentage of the shorter fibre, which still represents a large percentage of the Indian cottons. The bulk of the Indian crop is estimated as still ranging from three-eighths to seven-eighths in length, but many of the short staple varieties have undergone marked improvement through breeding during recent years. Some effort was made over a hundred years ago to improve the Indian cotton crop by bringing in exotic kinds, and the American upland

cottons thus introduced have recently been used as breeding stocks. Other exotic types, including sea island and Egyptian, have not succeeded in India.

The Dharwar–American or Sawgined–Dharwar, which is grown in the Dharwar District located in the southern part of the Bombay Presidency of Western India, dates back to 1819. At that time seed of American upland designated as New Orleans, a well-known commercial or trade type of that period, was imported and distributed near the town of Dharwar. Subsequently, the East India Co., about 1840 made experimental trials in Dharwar and other districts of the Bombay Presidency with a number of foreign cottons, of which New Orleans, Georgias (upland), sea island, and Egyptian were the more important. The results of these trials indicated that the New Orleans type was the most suitable of the several kinds tested for the Dharwar area. It became very popular in the District, and about 1860 the plantings of the New Orleans cotton exceeded those of the native Kumpta cotton (*Gossypium herbaceum*).

The Punjab Province of Northern India is at present the most important area in India for American upland. As early as 1825 seed stocks of both the New Orleans and Georgian trade types were carried to the Punjab from the Dharwar District. However, the droughts were too severe in certain years for the new kinds of cotton, and farmers continued to grow the indigenous or *desi* type, which was hardier. But fields of American cotton were grown here and there, and since crossing with the *desi* type did not occur, the American stock remained pure, perpetuated itself, and became more and more acclimated. This American stock became known as the *narma* (acclimated) cotton of the Punjab. Apparently the Georgian type persisted to a much greater extent than did the New Orleans type, probably because of the early maturity of the former.

An early effort was made to cultivate American upland cotton in what is now the United Provinces. The first undertakings were not successful, but further trials were started in 1870 at Cawnpore which terminated in the acclimatization of a variety known as Cawnpore–American. In the period immediately after the American Civil War a number of exotic cottons were brought in, including several types of American upland from other parts of India—such types as Cambodia and a Georgian type, Buri. Since 1900 a number of upland varieties from the United States, some of which were highly productive, have been imported by the cotton workers of India, but none has succeeded without some years of acclimatization and reselection.

Experiments with exotic cottons in the Sind date from 1846, when Egyptian seed was tried at Shikarpur and sea island at Rohri.

These trials were unsuccessful. From 1852 to 1854 sea island and New Orleans (upland) were again tried under the direction of an American planter without success. From 1868 to 1888 experiments with introductions were carried on near Hyderabad and Karachi which were rather inconclusive. These trials were both with American and Indian varieties.

Improvement in Modern Indian Cottons

The very short staple cottons of India, many of them one-half inch and less, and all less than seven-eighths inch, belong to the *Gossypium neglectum* and *G. arboreum* native species, and are cultivated in Central India, Central Provinces, Berar, Bengal and Assam. This cotton is suitable for spinning counts from 1 to 16 and amounts to a little more than 3,000,000 bales, or about 70 per cent. of the total crop of the country. The medium-staple cottons from seven-eighths to 1 inch belong to three species principally *G. herbaceum, G. indicum,* and *G. hirsutum.* The first two are native species and the last American upland. The medium-staple cottons are cultivated in Bombay, Madras, the Punjab and Hyderabad. This cotton is suitable for spinning counts upto 22. The growth of the American upland stock is chiefly in Bombay and the Punjab. The medium staple amounts to somewhat over 1,000,000 bales, or practically 30 per cent. of the crop.*

Most of the breeding and improvement work in India has been done in the Provinces and districts, where the medium staples have been chiefly grown. The work has been concentrated on better staple, higher gin out-turn, better yields, and disease resistance. Some work on staples longer than 1 inch with American upland long staple has been done but such strains or varieties have not been distributed to any extent as yet.

Bombay has always been an important cotton-growing Province. Its acreage represents on the average about 29 per cent. of that of the whole of India. Real or systematic breeding and improvement work began in the Province soon after 1900, as it did in the United States.

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* The growth over 1 inch in length is negligible or amounts to not more than 0.1 to 0.2 per cent. of the crop. Very little cotton produced in India is suitable for yarn above a count of 22. These longer cottons are mostly of the American upland type. However, one native variety, Surat 1027 ALF, is capable of producing counts from 26–34. Both American upland and native stocks are used for breeding better types of cotton in India. Egyptian and sea island have been less successful. The use of the native tree cotton is rather unpromising because of the very mixed condition of the types and the greater danger of insect damage.

The publication of Mendel's and of Johannsen's studies had its effect in India too. From that period up to the present Mollison, Fletcher, Gammie, Main, Shevade, Kottur, Kulkarni, Patel, Mankad, Prayag, Thadani, Desai and others have been associated with the breeding and improvement work.

Kumpta Cotton.—A trade type named for a port south of Bombay including a series of more or less indistinguishable varieties of the *Gossypium herbaceum* species—was one of the first of the native cottons turned to by breeders in the first decade of the present century. Mass selection for long and fine staple was begun at the Dharwar Farm in 1904. From this came Dharwar I and Dharwar II, the latter highly resistant to wilt. From a cross between these two came *Jayawant,* meaning victorious—a name justified by the yield, ginning percentage, staple length, and wilt resistance. Dharwar III was developed from a cross between two strains of Kumpta, and Dharwar IV from a cross between Ghogari (*G. herbaceum*) and Kumpta.

Gadag No. 1 was developed from the Dharwar–American grown in the Dharwar District for a number of years. This stock was first separated by Gammie into two types, hairy and glabrous, and later the hairy type was found by Kottur to be resistant to a disease known as red leaf blight. From this came Gadag No. 1, which at present represents the Dharwar–American in the District.

Banilla cotton originated from a cross of two native species, Bani (*Gossypium indicum*) with fine long staple and Comilla (*G. cernuum*) with high ginning percentage.

Surat 1027 ALF came from a cross between Ghogari and Kumpta, and it is now the longest staple native Indian cotton (1 inch or better).

In the Broach area of Bombay a wilt-resistant variety designated as BD8 (Broach, *Gossypium herbaceum* × Deshi 8, *G. neglectum*) has been developed.

In Northern Gujarat some breeding work on the native Wagad (*Gossypium herbaceum*) variety was done—the bolls of this cotton only crack and the cotton is hulled out in the farmhouses—which resulted in Wagad 4 and Wagad 8, and work has been in progress recently to cross Wagad strains with Surat 1027 ALF.

In the Sind the native cotton was found to be made up of several varieties of *Gossypium neglectum*—Rosea, Cutchica, Vera and Malvensis. Rosea was found to be superior and through plant selection the strain designated as 27 WN was evolved. Selection work with the Punjab–American strains has been carried on, as well as selection with sea island, Egyptian, and fresh American upland stocks, and many

crosses have been made. Among the strains already developed can be found those suitable for most purposes. These cottons are now being tested all over the area in well-controlled experimental trials. Crosses have been made of Punjab–American cottons with sea island, with Pima (Egyptian), and with the American upland variety, Meade. The progenies are under study, and in addition to direct plant-breeding work, information of value as to the inheritance of certain characters has been obtained.

In the Punjab, in addition to the Punjab-American 4F, developed out of the Narma or old Georgian type and occupying 1,000,000 acres by 1924, two others of this type were evolved—Punjab–American 285F and Punjab–American 289F. Two improved native varieties have also been grown extensively—Mollisoni, a selection from *Gossypium indicum,* and Roseum, a selection from *G. neglectum.*

In several of the other Provinces of India cotton-breeding work has been carried on. Two upland types have been utilized, Cambodia in Madras and Cawnpore–American in parts of the United Provinces. In these two Provinces, as well as in other political divisions of India, more useful strains from native sorts have been developed.

In recent years in India much emphasis has been placed on fibre quality and disease resistance. As a whole, the Indian cotton crop has been improved in quality to some extent, and in certain areas where the breeding work centered and better means of distributing the new stocks of seed have been worked out, much advance has been made. The greatest improvement in staple length has occurred in the Punjab, where American upland varieties have received the widest distribution.† Several well-defined wilt-resistant varieties have been developed in India in recent years.

Plant breeders in India have to overcome many traditional ideas and customs, and to contend with poor ginning management, inadequate methods of seed distribution, and poor marketing facilities. In spite of this they have already made a distinct contribution to the Indian cotton industry, and they are now so organized that much more progress in improving the quality of cotton will be made within the next few decades.

—*Year Book of Agriculture,* 1936.

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† In 1915–16 about 80 per cent. of the total Indian crop was less than ⅞ of an inch in staple length and the remaining 20 per cent. less than 1 inch in length. In 1923–24 the short staple amounted to about 67 per cent. and in 1933–34 to about 70 per cent. None was estimated to be longer than 1 inch. In the last year or two staple longer than an inch has been reported and this is thought to have come from important American varieties in the Punjab.

The Sago Industry in Malaya

There are two important species of sago palm, *Metroxylon sagus* Rottb., the smooth-sheathed variety, and *M. Rumphii* Mart., the spiny sheathed variety, present in the Malaya Peninsula, both in cultivated and in a half wild state. The former, which is a taller palm, is more abundant in Western Malaya, the latter in Eastern Malaya.

The palms grow to a moderate height, *M. Sagus* often attaining 40 feet, and throw up stems in succession from rhizomes, each stem in turn flowering, fruiting, and dying after a life of about fifteen years. They grow best on a swampy soil, and are propagated by means of suckers, but may also be grown from seed, which is a much less expensive method and is in other ways more satisfactory. Suckers are, as a rule expensive, and unless the removal from the parent tree has been carried out with the greatest care, their chances of survival are not great. In Malaya, the sago palm is not grown as a plantation crop, but is to be found growing along river banks and in low-lying areas in the vicinity of rivers. The palms are usually harvested when they are about twelve years old, and the trunks about 12 to 18 inches in diameter. They are cut into pieces 4 feet in length and floated in the river to the factories where the raw sago is prepared.

On arrival at the factory the cortex of each log is stripped off, an axe being employed for this purpose. The log is then placed on a bench and rasped by means of a board, studded with nails which is operated by two men.

The grated material, which in appearance resembles saw-dust, may then be despatched by boat to the larger Singapore factories. In most of the small factories, however, starch or crude flour is extracted from the logs, and despatched in that form to the factories at Singapore for conversion into "Pearl" sago or flour.

Singapore factories depend mainly for their supplies of raw sago on the Netherlands Indies, the chief centres of production being Bintulu, Sibu, Beletong, Bengkalis, Koedap, Sambas, Simbang, Pontianak and Kuching (Sarawak). A certain quantity is received from Batu Pahat in the Unfederated State of Johore. There are seven factories operating in the latter area, situated at the junction of the Sungei Simpang Kanan and Parit Bilal, where, with water close at hand, no difficulty is experienced as regards transport. It is this cheap form of transport that enables the industry to survive.

The areas under sago palm in Johore are estimated to total 1,814 acres.

The sago industry of the Batu Pahat District was established some forty years ago by Malays. At that time, the Chinese were

engaged in the more profitable trade in pepper and gambier, but they eventually became interested in the sago industry, and subsequently established themselves to the total exclusion of the Malays.

Yields

The yield of crude flour or starch varies with the size of the palm, and ranges between 250 and 650 lbs. per palm, the yield of sago flour approximating to 58 per cent. of the crude starch.

Manufacture of Sago in Singapore Factories

All factories in Singapore are advantageously situated, being located along the Kallang River, giving easy access to boats, and facilitating disposal of refuse which is either dumped at sea or sold as pig food.

Storage.—Consignments of raw sago as they arrive at the factory are placed in a spacious store-room and steps taken to ensure that each will be treated in the order of its arrival, thus guarding against deterioration or excessive fermentation setting in. Crude sago contains very fermentable substances, and within a few days of extraction and delivery at the factory the fermentation commences, and a very objectionable smell is given off.

Extraction of Starch.—The raw sago is transferred from the store-room to wooden tubs measuring 3 feet in height by 6 feet in diameter, the sides converging slightly towards the top. A piece of rope is tied across the mouth of the tub, which has been previously filled with fresh water; across the rope a piece of unbleached calico is placed covering one half of the mouth of the tub. The raw sago from which the starch is to be extracted is placed in this cloth and washed until as much of starch as possible is removed. The residue is then thrown out and subjected to a second and third washing. After about 36 hours, the supernatant fluid in the tub is siphoned off, leaving a layer of starch at the bottom, of about 2½ feet thick. A yellowish scum which forms on the top of the starch is first scraped off and the soft pasty mass is then scooped out. For this purpose, a special cutting implement, having a long chisel-shaped blade, bent in the middle and fixed in a wooden handle, is used. The blocks of starch are then transferred to another wooden tub filled with fresh water.

These tubs are in turn subjected to a vigorous stirring with a wooden paddle-shaped instrument. The suspended starch is then baled out by another labourer who pours it over a sieve made from the ribs of a coconut palm leaves, which is placed at the upper end of a wooden trough which slopes away from the tub. At the lower

end of the trough a number of wooden slats on which a piece of calico is spread, are placed. As the trough fills, the number of slats is increased so as to retain the increasing quantity of starch. When the trough is full, the starch is allowed to settle for two to three hours, and its surface cleaned of all foreign matter. It is then cut into blocks and transferred to a raised platform or table. The whole process is similar in many respects to the preparation of tapioca starch, and, in Johore, when supplies of tapioca roots are scarce, sago palm trunks are often purchased by factories and treated exactly in the same manner as tapioca roots for the extraction of starch.

When the weather is fine, the blocks of starch are removed to a concrete or tiled drying ground, where they are broken up into small fragments to facilitate drying. The flour is then spread on mats and raked occassionally. Six hours' drying is considered sufficient. In the event of rain falling, the flour is wrapped up in the mats and laid on wooden platforms raised a few inches off the ground by bricks, and is further protected from the rain by matting. The drying ground being in the form of a series of undulating ridges, provides protection from flooding during a heavy storm, while the good run-off for surface water enables drying to be continued with the minimum delay after the rain has stopped.

Preparation of Sago "Pearl".—A better quality starch is used for the manufacture of "pearl". It is first powdered and then passed through a sieve composed of coconut leaf-ribs, having a guage of 1/6 inch. After sieving, the starch is transferred to an oblong-shaped bag, the mouth of which is kept open by two pieces of wood tied crosswise. The bag is suspended by a cord from the roof and is rocked backwards and forwards for about ten minutes, resulting in the starch grains forming small spheres. The time required for the operation depends on the size of "pearl" desired.

The "pearl" is then passed through a similar type of sieve having a mesh of 1/7 inch and later through an iron gauze sieve of the same mesh; it is then fried or cooked.

In the cooking of "pearl", iron pans having a diameter of about 2½ feet and a depth of 6 inches are used. These are set in cemented firebrick over a furnace, which is fried externally.

Labourers engaged in the cooking of the "pearl" are provided with a piece of cloth, some "choon tay oil" (tengkawan fat) derived from the seeds of *Isoptera borneensis* and *Diplocnema sebifera,* an oval or kidney-shaped bamboo tray, a short wooden knife shaped to fit the curvature of the iron pan, and a small wooden tub.

The pan is wiped with the cloth, which has previously been soaked in tengkawan fat, and 4 to 5 lb. of "pearl" are thrown in.

This is vigorously stirred for five minutes and then removed and passed through a galvanized iron sieve of ⅛ inch mesh, for sizing. The "pearl" now undergoes a kind of baking. It is placed on a brick platform, about 50 feet in length and 15 feet wide, which is heated by fire burning beneath, and left there for four hours, during which time it is frequently raked to obtain a uniform appearance. Finally, it is passed through a sieve with round holes of a diameter of 1/8 inch, and later through a coarse muslin sieve. It is then ready for export.

Sago refuse, a by-product of the industry, is much used in pig-rearing by Chinese market gardeners, while the *ataps* made from the leaves are more lasting and are better than those produced from the Nipha palm, *Nipa fruticans* Wurmb.

Cost of Production

The following costs of production are based on a Chinese-owned factory with an output of 5,000 piculs (300 tons) of prepared sago per month.

Capital—	$
Land and Factory, Office, Labourers' Quarters	40,000
Equipment	8,000
Cost of four Junks	2,000
Total	50,000

The factory, complete with equipment and junks, is generally owned by a capitalist and leased to the operator.

Working Costs, per month—	$
Upkeep of Junks and Labourers' Wages	300
Insurance on Goods and Equipment	20
Rent of Factory	150
Labourers' Wages—100 @ 25 $ each (average)	2,500
Manager's Salary	100
Salary of 7 Clerks	200
Water and Light	325
Food Supply to Staff and Labourers	500
Supervisors' Wages (4 Head Labourers)	150
Lorry Hire	60
Fuel	450
Sundry Expenditure: Medical, Repairs, Replacements	300
Total	5,055

Labour

In a factory with a capacity of 300 tons of prepared sago per month, about 100 labourers are employed. They work in two shifts, namely from 4 a.m. to 1–30 p.m. and from 4 p.m. to 9 p.m. The second short shift is of fryers and sievers, for without this second shift output would be held up owing to the greater speed for completion of the earlier stages of manufacture. It suggests bad factory organization in that the frying and sieving department is not sufficiently large. The distribution of this labour in the factory is as follows:—

First Washing	8 men
Second Washing	4 „
Third Washing	4 „
Removing Blocks of Starch	4 „
First Sieving	4 „
Second Sieving	3 „
Third Sieving	5 „
Rocking Hammocks	5 „
Frying Starch on Pans	9 „
Rubbing and Grinding Lumpy "Pearls" ..	2 „
Chopping Wood and Fuelling	2 „
Breaking Block Starch and Sun-drying ..	18 „
Baking on Oven	3 „
Sundry Labourers	2 „
Total	73 men

The remaining 27 men are fryers and sievers, who because of the heat in which they have to work and the amount of work to be completed, carry out their task in the evening.

In the table below is given the cost of production of flour and pearl sago per picul, when the price of raw rasped sago is $ 50 to $ 65 per koyan (5,333 1/3 lb.), the present price range.

It is estimated that one koyan of raw rasped sago will give 22 piculs of sago flour or 20 piculs of pearl. In the factory mentioned, production is about 60 per cent. flour and 40 per cent. pearl.

It should be noted that packing is charged extra at the rate of 50 cents for every bag supplied and filled at the factory.

	Price of Raw Sago per Koyan	Gen. Factory Charges Items 1–3, 7–8, 10–12	Labour Items 4, 5, 6, 9	Cost of Raw Sago	Total
Flour ..	$ 50	42 cents	50 cents	$ 2·28	$ 3·20
	$ 65	42 cents	50 cents	$ 2·96	$ 3·88
Pearl ..	$ 50	42 cents	75 cents	$ 2·51	$ 3·68
	$ 65	42 cents	75 cents	$ 3·26	$ 4·43

The present (June 1937) Singapore wholesale market prices per picul of sago are Pearl, Small Fair $5.69, Flour, Sarawak Fair $3.55.

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